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AUTHOR Allen, Nancy J.
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ABSTRACT

This study examines indigenous models for the integration of science and culture into curriculum and instruction and was conducted in 13 Native American Indian schools over an 18-month period. In the summer of 1996, the Four Directions Challenge in Technology Project brought together teams of teachers, administrators, community members, and students from the schools for a two-week institute in culture, technology, and curriculum development. The teams produced thematic curricula and multimedia projects that incorporated science and culture. Classroom discussions, electronic journals, informal interviews, and curriculum products were used to determine group priorities and concerns, models for cultural integration, and effective ways to support local curriculum reform. Results indicate that although teams often shared areas of concern--and thus targeted similar science content--the models used for curriculum development differed according to community values concerning culture and instruction. Suggestions include providing communities with continued instruction in curriculum design and encouraging local control of content. Contains 39 references. (Author)

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# Indigenous Models for Science-and-Culture Curriculum Development

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Nancy J. Allen
Learning Technology Center
The University of Texas at Austin
Austin, Texas 78712
njallen@tenet.edu

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## Abstract

The purpose of this study is to examine indigenous models for integration of science and culture in curriculum and instruction. The study was conducted over an eighteen month period, during which the researcher worked with thirteen Native American Indian schools in curriculum reform. In the summer of 1996, the Four Directions Challenge in Technology Project brought together teams of teachers, administrators, community members, and students from thirteen Native American Indian schools for a two-week institute in culture, technology, and curriculum development. The teams produced thematic curricula and multimedia projects that incorporated science and culture. Classroom discussions, electronic journals, informal interviews, and curriculum products were used to determine group priorities and concerns, models for cultural integration, and effective ways to support local curriculum reform. Results indicated that although teams often shared areas of concern—and thus targeted similar science content—the models used for curriculum development differed according to community values concerning culture and instruction. Suggestions include providing communities with continued instruction in curriculum design and encouraging local control of content.

## Objectives of the Study

*Our main objective is the education of our kids (Native American[1] parent, on-line conversation, August 4, 1996, Lawrence Kansas).*

Native Americans have not fared well in America's schools. As a group, they experience the highest dropout rate, have the greatest percentage of students in special education programs (Stuck in the horizon, 1989; Tharp and Yamauchi, 1994), and show the least inclination to enter scientific careers of any minority population (Indian Nations at Risk Task Force, 1992). A reason that is often cited for this under achievement is that mainstream curricula may be culturally inappropriate for Native American students (Allen, 1995; Cahape and Howley, 1992; Indian Nations at Risk Task Force, 1992). In recent years, Native American educational leaders have increasingly demanded "culturally compatible curricula"—curricula that reflect Native culture, language, knowledge, values, and teaching styles (Jordan and Tharp, 1979; Tharp, 1989; Tharp and Gallimore, 1988). Recent reforms in education, which have opened the door to local control of schools and the recognition of muticulturalism, may have finally provided an educational climate in which Native culture may find expression.

*Native communities are now creating learning situations that combine traditional tools with modern tools, the drum with the computer. From elementary schools to the tribally controlled community colleges, Native youth are reaffirming the validity of their cultures. (Nancy Balow, in Cahape and Howley, 1992, p. 4).*

As the opportunity and responsibility for curriculum reform shifts to local Native American communities, it is important to clarify goals and standards. What do Native

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[1] Individuals of Native American Indian ethnicity will be referred to in this paper as *Native Americans*. When comparisons of ethnicity are made, the terms *Native* and *non Native* will be used. The meaning and use of the term *indigeneous* is explained in the main text of the paper.

Americans mean by "culturally compatible curriculum," and how is that phrase translated into science curriculum and instruction?

The goal of the Four Directions Challenge in Technology Grant, a five-year program funded by the Department of Education, is to restructure curricula in Native American schools through building on local cultures and values. Although the main focus of the National Challenge Grants is increased technology in schools, the Native American schools in the Four Directions Project envisioned the use of this additional technology as a means to curriculum reform. The vision was to use telecommunications for professional development and for accessing and sharing resources, and to use multimedia for the generation of curriculum and student demonstration of knowledge. The focus of this study, however, is not technology, but curriculum reform.

This study focuses on how science and culture are integrated when curricula for Native American students is generated under local control—the process, the products, and the models for curriculum development. These models I have entitled *indigenous* in reference not only to the Native American population of the study, but also to the grass roots approach to reform that is the central to the goals of the Four Directions Project.

Specifically, the questions that were addressed in this study are:

- How was culture defined and expressed in curriculum and instruction by teams of Native American Educators?
- What science content, strategies, and skills were identified as consistent with or conflicting with local culture and educational goals?
- What thoughts and concerns were expressed by those directly involved in the education of Native American students in regard to the new curriculum paradigm?
- What kinds of support may be offered at the university level to support indigenous school reform in science-and-culture integration?

## Significance

The significance of this study is that it contributes to our understanding of ways to facilitate empowerment for a population historically disenfranchised in science. It provides insights into models of curriculum development and ways to support local curriculum reform. The study contributes to our understanding of what is meant by culturally compatible curriculum for Native Americans and provides insights into appropriate methods for designing such curricula.

## Theoretical Underpinnings

> *I take with me support in the words that I heard every day growing up with my grandparents: "Love the people, take care of the people, you never know when you will need them." (Native American educator, August 2, 1996, Lawrence, Kansas).*

The theoretical foundations of this study are socio-constructivism (Vygotsky, 1978; Solomon, 1987, Wertsch, 1991). Socio-constructivist is an epistemology that suggests that knowledge is constructed within social interactions. Culture is inherently social, and it is specifically those webs of meaning created in social interaction that are the focus of the Four Directions Project and of this study.

## Population

The study involved participants from schools participating in the Four Directions Challenge in Technology Grant. The study was conducted during the first year and a half of a projected five-year plan. Nine schools and three universities (The University of Texas, Kansas University, and The University of New Mexico) formed the initial consortium, with four new schools and Haskell Indian Nations University being added shortly before the first summer institute (eight months into the project). The thirteen schools presently in the project represent geographic and tribal diversity. A short description of each school follows.

- Indian Island School is located on an island in the Penobscot River in Maine. The Penobscot Indian Nation is the oldest documented continuously operating government in North America. The Island on which the school is located is the seat of that government and serves the Penobscot Indian community.
- Indian Township is a sister school to Indian Island. Indian Township is located in the extreme north of Maine, on the wooded shores of a large lake near the Canadian border. Its community members are members of the Passamaquady Tribe.
- Takini Tribal School is located eighty-five miles from the nearest airport, on the majestic South Dakota plains, and serves three communities of Lakota Indian students. The word *Takini* means *survivor* and refers to the fact that the students are descendants of the survivors of Wounded Knee.
- Standing Rock School, one of the largest schools in the consortium with over 1000 Dakota students, is in central North Dakota, on the Missouri River.
- Ahfachkee School is located on the Big Cypress reservation in the middle of the Everglades in Florida. Ahfachkee means "Happy" in the language of the Seminole Nation.
- Nah Tah Wahsh (Soaring Eagle) School is located in the upper peninsula of Michigan and serves the Potawatomi Indians of Hannahville Indian Reservation.
- Fond du Lac Ojibwe School, near Cloquet, Minnesota, is located in the beautiful forests between the Twin Cities and Duluth.
- Dilcon Boarding School is located amid volcanic cones and majestic desert vistas near Winslow, Arizona. Dilcon strives to teach students of the Navajo Nation to "walk in beauty...without fear or malice" (school mission statement).
- Seba Dalkai School is located on the Colorado Plateau in Northeastern Arizona in the community of Teesto. In the Navajo language this area of the reservation is known as "Tsezhintah," which refers to the many picturesque buttes that dot the magnificent landscape. Seba Dalkai has played an important role in the community since 1935.

- Laguna Pueblo is located about 40 miles west of Albuquerque, New Mexico. The Laguna Department of Education is the agency charged with management of the grant. Laguna has two schools participating in the program, Laguna Elementary School and Laguna Middle School.
- Quileute Tribal School is located in extreme northwest Washington state on the Olympic Peninsula. Killer Whales may be seen in early spring scratching the barnacles off their backs in the shallow, rocky waters beneath the school windows.
- Lummi Tribal School is located within sight of Canada, on a narrow spit of land that juts out into the Pacific Ocean. Lummi is a small tribe with a rich history, as one of the coastal tribes of the Northwest.

## Design and Procedures

### Design

The design of the study is descriptive and interpretive (Isaac and Michael, 1981; Lincoln and Guba, 1985; Miles and Huberman, 1994). The purpose of the study is to give interpretive structure to expressions of personal and group meanings by the participants.

The procedure followed for data collection and analysis is the constant comparison method (Bernard, 1988; Glaser and Strauss, 1967; Jacob, 1987; Taylor, 1976). According to this method, the researcher at first intuitively divides data into categories; as more data is assembled, the researcher adjusts the categories and shifts the data accordingly. Eventually the categories become clear and the rules that define them emerge. Since the purpose of this research was to find and express such rules (and the models proscribed by those rules), the constant comparison method was followed.

### Data Collection

Central to this study are data collected during a two week summer institute held in July of 1996. Baseline data in curriculum and instruction, however, were collected during the ten months

prior to the institute, and clarifying and supportive data were collected during the eight months following, for a total period of eighteen months.

October, 1995-July 1996: Preparation

Participant schools were visited by the researcher during the months preceding the summer institute. During these visits, evaluation was made of existing models of curriculum and instruction. The evaluations were based on classroom observations, staff interviews, written school reform plans, and, when available, curriculum framework documents. A written report was completed by the researcher following each visit.

These visits provided baseline data for the nine initial schools. Four new schools were selected to join the consortium just prior to the summer institute. The researcher met with the teams from the four new schools early in the summer institute to discuss their current curriculum and instruction models so that baseline data could be established for the four new schools as well.

July, August 1996: The Institute

The summer institute was held at Haskell Indian Nations University and consisted of two weeks of 18 hour days. Activities included scheduled classes, team project work, cultural events, and group recreation. Although team members could choose among classes, they were expected to participate fully in all team projects. Classes were provided in telecommunications, multimedia, thematic curriculum development, and cultural inclusion. Native American artists, scientists, poets, educators, and cultural leaders were guest presenters. Cultural events included a variety of traditional Native American activities, such as a Pow Wow and a Sweat Lodge Ceremony. Recreation included both traditional Native American and traditional Western activities, such as stickball and basebase games.

Each of the original eight schools sent a team of four to eight individuals to the summer institute. The four new schools were allowed only two members per team. The teams were composed of individuals from the following categories: teachers, administrators, students, parents, and non teaching community members. Student representatives ranged in age from eight to sixteen years.

It is important to note that not all, or even a majority, of educators in Native American Schools are Native American. Depending on the area, ethnic composition of school staff varies greatly. The thoughts and beliefs about culture and curriculum in this study were gathered from Native American participants (unless otherwise noted), but team projects were developed by the people who represented that school, whether Native or non Natve. For that reason, when team projects are discussed in this paper, the ethnic composition of that team will be noted as well. With the exception of the two-member teams, which typically were too small to provide a reasonable sample, the composition of the teams almost invariably reflected the ethnic composition of school staff they represented. The ethnic composition of the teams ranged from 100 per cent Native participants to 100 per cent non Native participants.

At the beginning of the summer institute, the teams were instructed to produce some kind of product. The teams could construct a product of their design, but to receive the three hours of college credit offered for the institute, the project had to have the following characteristics:

- reflect the theme "Cycles and Changes,"
- be interdisciplinary, including at least two subject areas, and
- involve at least two of the following: multimedia, science, and culture.

Teams were encouraged to include students, parents, and non teaching members of the community—as well as teachers and administrators—in curriculum design and instruction. All teams were expected to demonstrate their projects on the final day of the institute.

During the institute, the researcher was with the participants constantly, in formal and informal classroom settings, as a team mentor, and in social settings. All participants had email accounts to which the researcher posted discussion questions several times a week. Participants responded to such questions as, "What impact do you see this project having in your local school and your local community?" "How do you see students being involved in the processes of curriculum development and instruction?" "What role should the school take in cultural integration?" The email discussions were collected in a central file for review.

The researcher also conducted classes in thematic curriculum design and cultural integration strategies. Every participant was provided with a planning booklet for thematic curriculum design. The grant had specifically identified a thematic curriculum paradigm because of research findings that indicate that a holistic approach to curriculum and instruction is more consistent with Native American traditional learning strategies and more effective with Native American learners (Garcia, 1991; Mehan, 1996; Tharp and Yamauchi, 1994).

It was suggested to the teams that they choose a topic for their project that was important to their community, but otherwise the subject matter and project design were left open to team discretion. Team projects were presented during the final two days of the institute and were also recorded on disc for later viewing. Lesson plans and other products were also turned in to me for review.

August 1996-March 1997: Follow-up

Staff at the schools strongly reported a need for more support in curriculum development. For that reason, The University of Texas offered an on-line course in thematic curriculum design for teachers from the participant schools, which I taught. I also conducted on-site workshops and curriculum support for several of the schools, at school request. Data from these experiences, such as on-line and on-site conferencing and curricular materials, were used for triangulation.

After examining all data and formulating tentative models, I felt additional data were necessary to clarify certain hypotheses—I wanted to hear directly from the Native American participants on certain issues. A survey was sent out to the Native American members of the teams; six participants from five tribes returned the completed surveys. The questions were:

1. How would you define "culture"?
2. Is culture important in education? If so, in what ways?
3. What do you think the role of schools should be in regard to culture?
4. When you were a student, did you experience cultural conflicts? (Specific examples would be helpful).

5. Do you know of any ways in which science, as it is taught in your school or in mainstream schools, conflicts with the cultural values of children in your community? (This can refer to specific content, textbooks, teaching strategies, ethics, etc.)

6. Can you think of ways that science education and the culture of your students are mutually supportive?

7. What advice would you give to people who teach science, write science curriculum materials, or prepare teachers of science in regard to meeting the needs of students whose culture differs from the mainstream.

A final opportunity for data occurred in discussions with participants during a recent three-day meeting in Austin by cultural representatives from eleven of the thirteen schools.

## Data Analysis

### Overview

Data of interest were in three areas: culture (values, content, strategies, and restrictions), science (content, strategies, and skills), and curriculum design (form, quality, and participant concerns). All data were reviewed and expressions pertinent to each of the three interest areas were noted.

### Generation of Models

Within each interest area, data which seemed to express similar content, values, or feelings were grouped together. From these groupings, interpretive models were generated to summarize and describe the groups. Whenever possible, the elements of the models are supported by the participants' own words.

### Validation

The completed study was sent to participants for review and comment, to ensure that their thoughts and intentions had not been misrepresented and to ask whether the interpretive models seemed true to them. According to Lincoln and Guba, "truth value," or

internal validity, asks how to establish confidence in the truth of the findings of an inquiry for the particular subjects and context of that inquiry (1985). Truth value therefore corresponds to the truth as it is perceived by the respondents. In addition to participant review, triangulation and prolonged involvement were used to increase the validity of the study (1985).

## Findings

### Introduction

Because of the interpretive nature of the study, findings and discussion are presented together. They are presented in three sections, representing the three areas of interest of the study: culture, science, and curriculum.

### Culture

#### Diversity and Community

> *For our people to share not only their rich history within their community but to reach out to other Native Americans is wonderful (Native American educator, on-line conversation, July 30, 1996, Lawrence Kansas).*

The participants within the Four Directions Project are a community. They are a community that share a vision of school reform that includes technology and cultural integration. They belong to the larger community of Native Americans. As such, they share many problems, concerns, values, and traditions. It is important to note, however, that they also represent a rich diversity of ancestry, history, art, literature, traditions, economics, geography, and personal and community characteristics. Figure 1 represents this expanding, encircling wheel of culture. It is important to note that the cultural wheels of individuals may intersect without being congruent. This cultural wheel is one of the conceptual models accepted by the Four Directions community to be used in curriculum development.

The participant-schools in this study share many characteristics: they are all Native American reservation schools, they all receive at least part of their funding through the Bureau of Indian Affairs, and they are all dedicated to school reform and educational quality. Most of the schools also share the characteristics of geographic remoteness and a higher-than-average incidence of social and economic stress among the student population. Noting these similarities can be an interpretive methodology, but should not be used stereotypically. All shared characteristics should be considered as possible influences when interpreting observed similarities, and the diversity of the group should also be recognized and appreciated.

Avoiding ethnic stereotyping

*Each tribe has their own ways (Survey 3, question 4).*

In conducting research concerning a cultural minority group, there is always the danger that one's work will be used to stereotype the individuals within that group rather than as an aid in understanding their similarities and the reasons for those similarities. Ethnicity may be an important shared experience; but other shared or unshared experiences may be at least as important in determining cultural characteristics. For example, previous research has suggested that Native and non Native students who share a community environment that differs significantly from the mainstream may demonstrate more similarity to each other than to their peers who do not share such an environment (Haukoos and Chandayot, 1988; Wauters, Bruce, Black, and Hocker, 1989). Chrisjohn and Peters suggest that students who grow up on reservations do not think any differently than students anywhere; rather, they have different experiences (1986).

The temptation to stereotype may be particularly acute concerning minority groups about whom the mainstream has limited knowledge or understanding. Such stereotyping may be inaccurate, demeaning, and patronizing (Charles, 1993; Greer, 1993; Stutzman, 1993). A participant in the current study noted:

> *Watching the cowboys and Indians was rather amusing, when I realized that I was a Native. The concept of Indians being naked was soon not very funny. (Survey 3, question 4).*

The same participant expressed a concern that such demeaning of culture may interfere with educational achievement.

> *..culture is very important [in education]. It is important because it lifts the children's self esteem and self identity. With a high self esteem, their learning will exceed a high achievement in their education. Their culture can reassure their learning as well as comparing other cultures. It is important to know themselves and it can be passed on to their children, so their culture will not die out (Survey 3, question 2).*

Another danger of cultural stereotyping is that it may mask individual problems and needs (Lee, 1996) as well as individual strengths and talents (Grant, 1988). This concern was often expressed by the participants.

> *When I was in school, I would get so mad! "Indians think this way; Indians are that way." They never paid attention to what that child, that child, needed for academic success (Native American educator, personal conversation, March 8, 1997).*

The partners in the Four Directions Project are seeking to avoid the effects of stereotyping in curriculum design by three means: first, recognizing that the student is at the center of the cultural wheel and must be at the center of instructional design; second, by encouraging the development of curriculum on a local level by individuals who share and understand the cultural experiences of the students; and third, by involving the student as a partner in curriculum design and instruction. The degree to which these goals are presently being realized is discussed in the curriculum section of this paper.

The importance of culture and language

Figure 2 illustrates some of the similarities and differences in beliefs observed among the participants in this study. Statements enclosed by only the large circle were held in common by the participants. Statements within the smaller circles represent subset beliefs. For example, two findings that were strongly expressed by the whole group were the importance of culture in education and the importance of language to culture. Every team, regardless of the ethnic

composition, strongly supported the concept that the culture of the child must be addressed in effective curriculum and instruction. The importance of tribal languages was also clearly acknowledged; however, not only do the tribes speak different languages, but the problems related to those languages are very different. At one end of the spectrum of language-related problems, tribes are struggling to preserve or rediscover their language; at the other, tribes are struggling to teach English as a second language. The following quotes illustrate these findings.

> *Our culture is very important in our ...tribe, especially the language. Because more of our younger generation don't talk the language, and we are losing it. There are very few of us still speaks the language (Survey 5, question 2).*

> *There are only a few people left who know the language. When we lose our language, we cease to be a people (Native American cultural leader, group presentation, March 8, 1997, Austin, Texas).*

> *Let me speak...in the words that come with my people (introduction to a prayer by a Native American educator, March 9, 1997, Austin, Texas).*

Other participants spoke poignantly of their own school experiences concerning culture and language.

> *We were never allowed to talk in our language in our schools. We were always told to speak in English (Survey 6, question 4).*

> *Question: When you were a student, did you experience cultural conflicts?*

*Answer: Yes, very much so because I only knew my language, and it was hard for me to learn how to read. No one at home speak or read English, back then (Survey 5, question 4).*

*We were not allowed to speak our language among each other. We had to speak only English. We didn't know how to speak English, we were only five, six years old. Our language is our culture, because that is our way of thinking and communication. We were like, forbidden our culture and soon became ashamed. Those students that spoke our language were given soap to eat. The feeling was awful! We were helpless and could not speak in any form or protest.*

*We read books of an unknown culture. Who were Dick, Jane, Sally, Puff, or Spot? Where was the city! What was that! We wondered as we read. Books always contained Non Native society and their ways. It was not our way. We did not understand them. Their morals were different.*

*Speaking and thinking in English was difficult. It was hard to read English, with their vocabulary, and then switch it, to think in my language, to understand a concept in school (Survey 3, question 4).*

I believe what the participants were trying to express is that language is far more significant than being literate in one or another language. Language and culture are tightly interwoven, the cultural experience and the words to express that experience are one— "The words that come with my people." One Native American, a talented educator who is fluent in both English and her Native language, expressed that translations may not always give appropriate meaning what one is trying to say, a statement that is also supported by research (Allen, 1995; Cobern, 1996).

*My grandma used to say that when you do things out of the goodness of your heart then the good always returns to you—not exactly in those words*

*but in our language. This is probably the best way I can translate that to English (on-line conversation, August 1, 1996, Lawrence, Kansas).*

The relationship of culture to education

Although there was consensus about the importance of culture, there was diversity in beliefs concerning how to define culture and what the relationship between education and culture should be. This diversity was expressed not only in words, but also in the content, form, and strategies of the designed curricula. These differences were present at the tribal level as well as the personal level. Some tribes specifically want their language, traditions, art forms, music, dance, and literature taught within a school setting. All teachers are expected to weave traditional cultural content into the fabric of instruction. Other tribes have culture classes and see culture as one of many important subjects; a subject that, like other disciplines, is best taught by an expert in the field. For other tribes, a school setting is not considered an appropriate forum for teaching culture; rather, sensitivity to the culture is expected at all levels, with teachers contacting a community member whenever there is a doubt about the appropriateness of any content or instruction. Still others see the appropriate integration of culture as tapping into the current, everyday needs and interests of the students—the "right now" culture in which the students live.

These differences are substantive and real and must be considered in judging the cultural compatibility of curriculum and instruction. The following quotes illustrate these differences.

*The school should mandate teaching of the culture...(Survey 3, question 3).*

*Culture is important in education, but it should be in balance with what the students need to know to succeed both on and off the reservation (Survey 2, question 2).*

*"...culture goes beyond one's ancestral roots. Educational systems have a responsibility to see that all students understand cultures of the home, the workplace and of the world...(Survey 1, question 2).*

*"In Indian schools...our culture should be studied along with other subjects just like math, English, reading, etc. (Survey 5, question 3).*

*I think it is important to respect the student's culture, but I don't feel that schools should teach culture (Survey 4, question 2). Some tribes have specific age limits and limits on amount of knowledge that young children need to have--even allowing boys or girls to know certain things in life and the environment (question 8).*

*I think it's great that we should be teaching about our communities, but I'm not sure I feel comfortable about doing it all the time. I don't feel that I am knowledgeable (enough) of the community I work in. I can only touch on those things that are universal to all indigenous people. I have encountered many parents who tell me it is their job to teach about their culture because it is more personal to their family and I respect their view. I can make connections between what is in our community/environment to science and math (Native American educator, teaching cross-tribally, on-line conversation, August 2, 1996, Lawrence, Kansas).*

These findings support the paradigm of local development of curriculum. Although Native American communities share the need for curricula that are culturally compatible and share many experiences and values, they do not share a single culture. A "one size fits all"

model is not appropriate for Native American schools. The findings in this study clearly indicate that cultural content, values, and goals differ among tribal communities. These findings support a model in which curricula are developed *by* tribal communities, rather than *for* them.

Science

Consensus also existed among the participants in regard to beliefs about science. Only two statements concerning science are recorded on Figure 2, and both are within the "shared beliefs" part of the figure. The participants were in agreement with these statements:

- There is no reason why science content, when monitored by culturally-informed individuals, should conflict with the values and goals of Native American communities.
- Science instruction, when taught within a Western paradigm, may and often does conflict with the educational needs of Native American students.

Science Content

Several of the participants noted that rather than conflicting, the content of science and Native culture were mutually supportive:

> *In itself, the world of science education mutually supports the Native culture. Science is based on observation and testing hypotheses. Our ancestors were the first scientists. They observed, gathered evidence, as supported by early legends, and made a judgment which was held to be true (Survey 1, question 6).*

> *Science—the environment— is always relevant to Native ways of life which is tied to the land and the power of Nature (Survey 4, question 6).*

*The students participate in the science fair at our school. They use their culture...to help their projects. Their hypotheses are supported around their cultural values, aspects and environment. These projects usually motivate their learning of science and culture (Survey 3, question 6).*

The caveat was constantly repeated, however, that a strong connection must be maintained between those who teach science and those who understand local culture.

*...teachers not aware of community ways should have local resources to help them (Survey 4, question 5).*

*[There are no conflicts in our community] because we are very careful to be culturally sensitive (Survey 2, question 5).*

*The [science] staff works closely with community members in order to incorporate culture into science (Survey 2, question 6).*

My experience in the schools supported this finding. In one instance a group of teachers who were non Native, but who clearly respected the culture of the community in which they taught, designed a thematic unit around an important cultural symbol. They were careful to research their information and to recognize their cultural limitations.

*I would think it would not be for me to decide what is important for students to learn about the [symbol]. I would like to students to use the ... information they have learned in Science. They would be responsible to find out what cultural items fit into the [information they learned in science*

*class]. They attend Culture Class, and have access to Elders for resources (non Native Teacher, on-line conversation, January 1997).*

Even with these precautions, however, when the materials were reviewed by indigenous members of the staff, several important changes were necessary before the materials were considered compatible with the culture of the community.

Another example in which potential conflict was avoided through communicatiion was reported by a parent in survey data.

*For example, my son was asking me, almost each week. If science textbooks explain that sun stays in one spot all the time and the earth turns on its axis, then how come our culture and history has a different story? I had to explain the differences. In the mainstream of science, the sun does not move. But in our culture, we have a Sun Bearer. He stopped asking when I explained the difference.*

Science Instruction

A consensus was also noted among the participants in the belief that science was not always taught in a way that met the cultural needs of the students. This finding, that the teaching methods of science rather than the content of science are more likely to cause conflict for the Native learner, is also supported by other research (Allen, 1995; Deloria, 1992; Kawagley, 1995).

*The only conflict I would think is the teacher, as how he/she teaches the science. Each teacher has their own way. The textbooks don't have any cultural values [that support] our culture but I know a few of the teachers implement the culture, so the student will understand the concept or help remember the concept (Survey 3, question 5).*

*Not every teacher utilizes instructional methods that meet the unique needs of the students; i.e. hands-on experiments, cooperative learning, going from the known to the unknown (Survey 1, question 5).*

*Our people have traditionally learned holistically. Tearing things down to understand them is not our way (Native American community member, curriculum development class, July 28, 1996, Lawrence, Kansas).*

The participants had suggestions on ways to minimize inappropriate teaching methods. As with culture, the suggestions may be summarized as, "Involve the community."

*...more hands on teaching and less talk (Native American educator, on-line conversation, July 29, 1996, Lawrence, Kansas).*

*...observe classroom in [those] localities before setting goals, standards, developing materials (Survey 1, question 8).*

*...encourage community and parental involvement in school activities (Survey 4, question 2).*

*Make sure [science instruction] does not conflict in how [the students] were brought up and their traditions (Survey 6, question 8)*

*Work closely with ...resources within the community (Survey 2, question 8).*

*If the "new" thematic way of teaching involves the family then the amount of participation from families and students will be that much more, right? (Native American educator, on-line conversation, July 21, 1996, Lawrence, Kansas).*

*The school could form a committee to decide how culture will be taught in the science curriculum. Would the culture be generalized, or specific in some areas? How much of the culture would be taught with the science? What materials would be used? School board and community people could assist with the curriculum (Survey 3, question 8).*

Curriculum

The previous sections of this paper focused on the thoughts and beliefs of the participants. The focus of this section is team actions. How were these beliefs and priorities expressed in the curricular products and plans for instruction that were produced by the participants?

Curriculum and Instruction —What to Teach?

*We always have trouble finding quality cultural material. One source I have straight from [a government office] even has us living in the wrong place. (Non Native educator in Native American school, on-line conversation, July 29, 1996, Lawrence, Kansas).*

Of the eleven teams that completed curriculum projects (the other two teams concentrated on web page generation), ten chose environmental science as the content of their units. The eleventh team chose the topic of survival, into which environmental science was woven. Eight of those ten concentrated on the biological sciences and two chose water as a topic. This finding is not surprising. The teams were generating only one curriculum unit during the institute, so it is reasonable to expect that science content of high priority would be selected. Native Americans have strong historical ties to the environment (Allen, 1992; Deloria, 1992; Kawagley, 1995; Simonelli,

1991), and much of their literature, art, and music reflect this relationship. The environment continues to be a concern of Native American people, as they struggle with managing large tracts of environmentally fragile land and valuable natural resources. It is reasonable to expect that the environment might have high priority as science content and that if only one unit were to be generated, it would focus on the environment. My experiences in the schools, however, reinforced this finding—that environmental science tended to be the content for most culture-and-science curricula.

Another subject that often received high priority in locally-generated curriculum was personal health. Again, this reflects a real community need. Native American communities currently combat tuberculosis (400% greater than for the general population), alcoholism (332% greater), diabetes mellitus (139% greater—affecting 50% of some Native populations), pneumonia and influenza (44% greater), and suicide (28% greater) (*Toward True Native Education*, 1992).

As a science educator I was concerned, however—when reviewing the team projects, the projects I saw in the school, and curricula being generated through the on-line class—with the lack of significant representation of the physical and earth sciences. Weather and water were included in curricula, and one unit touched on volcanism (a locally significant topic). For the most part, however, the curricula reflected the biological sciences almost exclusively.

Curriculum and Instruction—By Whom?

> *Perhaps sharing power can be scary—for the giver and the receiver (non Native educator of Native Americans, on-line conversation, July 28, 1996, Lawrence, Kansas).*

The curriculum model taught at the institute and in the on-line course encouraged a perspective of "teacher as co-learner." Educators were encouraged to examine ways to include students, other staff, and non teaching members of the community in the generation of curriculum and in classroom instruction. The teams were further instructed, however, to plan in a way that was comfortable, to use a model that worked for them and for their situation.

Some of the teams produced products and plans that were teacher-planned and teacher-directed. A reason often given for selecting this paradigm was that they were trying out a new type of curriculum (thematic) and trying to incorporate new technology (computer applications). Until they were comfortable with their own competencies, they did not feel comfortable including students. They wanted something to teach before they began teaching. It is interesting to note that the non Native team members were the ones who expressed this fear, and it was teams with the fewest Native team members that followed this paradigm in curriculum and instruction. Some teams had, in fact, expressed their positions in this matter prior to the institute, in team selection, by opting not to include in their team students or members of the community who were not school staff. It should be noted, however, that whatever the team composition or the curriculum development model, all teams had the cultural and educational needs of their students as the focus of curriculum and instruction. It was the expression, not the intent, that differed among teams.

Team products exhibited a range of shared power for curriculum and instruction, from the teacher-directed paradigm (discussed in the preceding paragraph) to a collaborative paradigm, in which non teaching community members and students were intimately involved in all aspects of curriculum and instruction. Teams most comfortable with a shared-power paradigm were those with the highest percentage of same-tribe participants both on their teams and on school staff. Figure 3 illustrates this dual continuum— percentage of Native American staff of the community tribe and degree of power sharing in curriculum plans. As one Native American educator commented, on being asked about the degree of inclusion, "Power is not always positive, right?" (on-line conversation, July 27, 1996, Lawrence, Kansas).

> *In our educational system, people becoming teachers were led to believe that they are the authority for our classroom. This tends to make us stand in front of the room and lecture. It is changing and teachers are becoming the facilitators rather than lecturers. I see the 4D project impacting students though the teachers. We are now at the beginning of a time when the school staff is seeing the importance of a community based curriculum (Native*

*American educator, on-line conversation, July 24, 1996, Lawrence, Kansas).*

Curriculum—How to Teach?

*I believe that we will be taking back a whole new style of teaching. Even though I don't think were quite ready to jump right into it with both feet, it's a start! (Native American educator, on-line conversation, August 3, 1996, Lawrence, Kansas).*

Science may be taught in many ways. As teams planned for instruction, which strategies were chosen seemed to depend on who would be doing the teaching. Teacher-directed units generally included conventional Western teaching strategies, such as teacher-directed discourse and teacher / text delivered content (as described in Allen, 1995; Lemke, 1990; Rosenbery, Warren, and Conant, 1992). In the plans with more community involvement, strategies were more likely to be discovery-oriented and collaborative, with students generating as well as displaying knowledge. Without exception, however, regardless of the instructional strategies chosen for this project, teams expressed a goal of moving toward a more facilitative role for teachers, a model which has been shown to be more effective with Native American learners and other cultural minority students (Garcia, 1991; Solomon and Rhodes, 1995; Vallo, 1988).

Curriculum and Instruction Models

*Decisions about our schools...must happen at the local level (Native American community member, group presentation, March 8, 1997, Austin, Texas).*

From the total data, three interpretive models were generated (Figure 3). Rather that falling neatly into a single model, the curriculum and instruction in any one school usually fit more or less into one of the models. The titles given the models are my own rather than generated by the population and represent only a place to begin. These models are a way for me to express what I observed within this sample of Native American schools. They are descriptive only, not evaluative,

and are intended to be helpful, not definitive. I have entitled the three models as culturally-sensitive, culturally-enriched; and culturally-immersed.

Culturally-sensitive

In the culturally-sensitive model, curriculum is developed or modified on the local level by the teacher or a group of teachers. Culturally-informed community members work closely with teachers to insure that no inappropriate subject matter or strategies are employed. If culture is explicitly included at all, it is in the area of language. In selecting topics for curriculum development, care is given to consider student needs and prior knowledge. Instructional strategies may include those known to be effective with Native American students and other cultural minorities.

Culturally-enriched

In the culturally-enriched model, a teacher or group of teachers may work with a culturally-informed member of the community or a staff member of the school hired specifically for her expertise in cultural matters. Together they look for ways in which cultural subject matter may be introduced within the teaching of other school subjects or in a culture class. Language, literature, history, and art (including the performing as well as the visual arts) are generally the areas from which content is chosen. Often special events are planned through which the culture of the people may be specifically taught. Community members are often invited to give special programs or to talk with classes about certain subjects.

Culturally-immersed

In the culturally-immersed model, the community is involved at every level of curriculum design and instruction. Community members may be found in most classrooms as facilitators, rather than guests. The culture is taught extensively, explicitly, and in all disciplines. Cultural knowledge, cultural values, and cultural ways of learning and knowing are considered essential in the educational setting.

The reasons a school chooses one model over another may be many and complex. The reasons are also community-based.

## Summary

Ways must be found to help Native American students reach their full potential in science. Culturally compatible curriculum has been targeted as a means to achieve that goal, but culturally compatible curriculum may mean different things to different communities. Although there are many commonalties among Native American communities, there are also many differences. For curriculum to be truly culturally compatible, it must reflect the needs, priorities, values, resources, and richness of the local community. For some communities that means explicitly incorporating cultural teaching; for others, it means taking care not to offend. These decisions are only appropriately made at the local level. Locally-generated curricula would seem to be a powerful means to achieve these goals.

The problem, however, is that educators in Native American schools, like educators everywhere, are busy people. They are required to have expertise in many areas. Areas in which few have professional training are curriculum design (in general) and in thematic / integrated science curriculum design (in particular). In addition, many teachers, especially those who operate within a Western educational paradigm, are uncomfortable sharing the responsibilities for curriculum and instruction, and thus do not fully utilize community support. Collaborative efforts between universities and local Native American communities may mitigate this problem. Although the findings of this study suggest curricula may be best developed at the local level, universities may facilitate this process by contributing resources and by providing convenient professional development (such as on-line and on-site training). In summary, if individuals in Native American schools are going to be asked to develop extensive amounts of curriculum, they need to be provided the training and the resources.

This study suggests that science curricula generated at the local level may be more culturally compatible for the Native American learner. The standard by which such curricula are judged, however, must be their effectiveness in the classroom. Will such curricula increase the motivation or academic achievement of Native American students in science or encourage entrance into

scientific careers? Preliminary research indicates that it may (Killackey, 1989; Matthews and Smith, 1994); however, much more research is needed to establish whether, how, and why such materials are better for Native American learners.

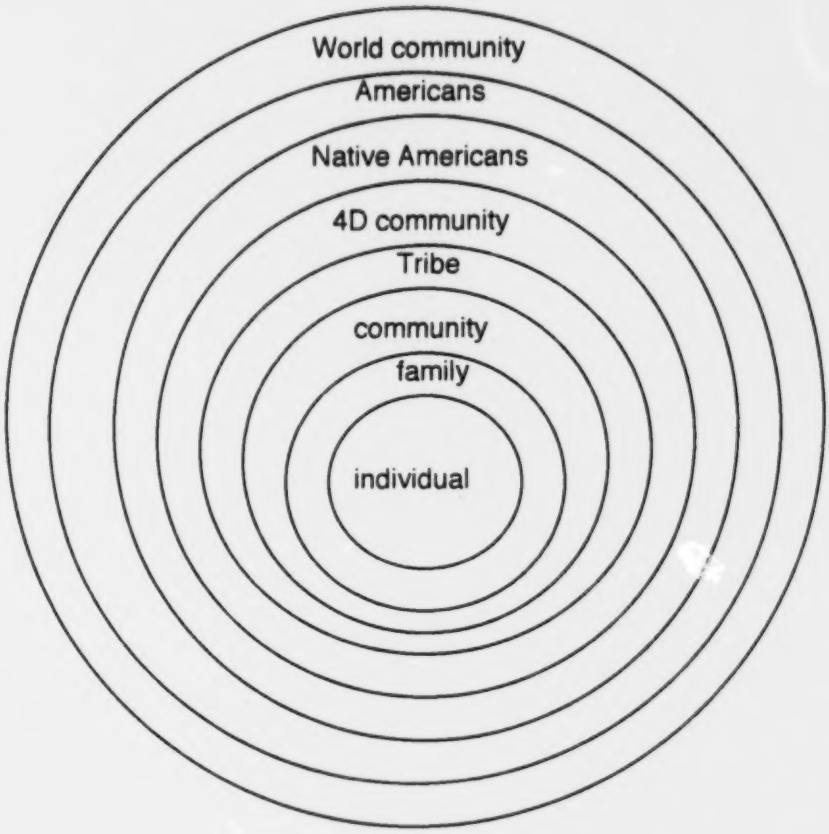


*Figure 1.* A culture wheel illustrating multiple levels of cultural influence.

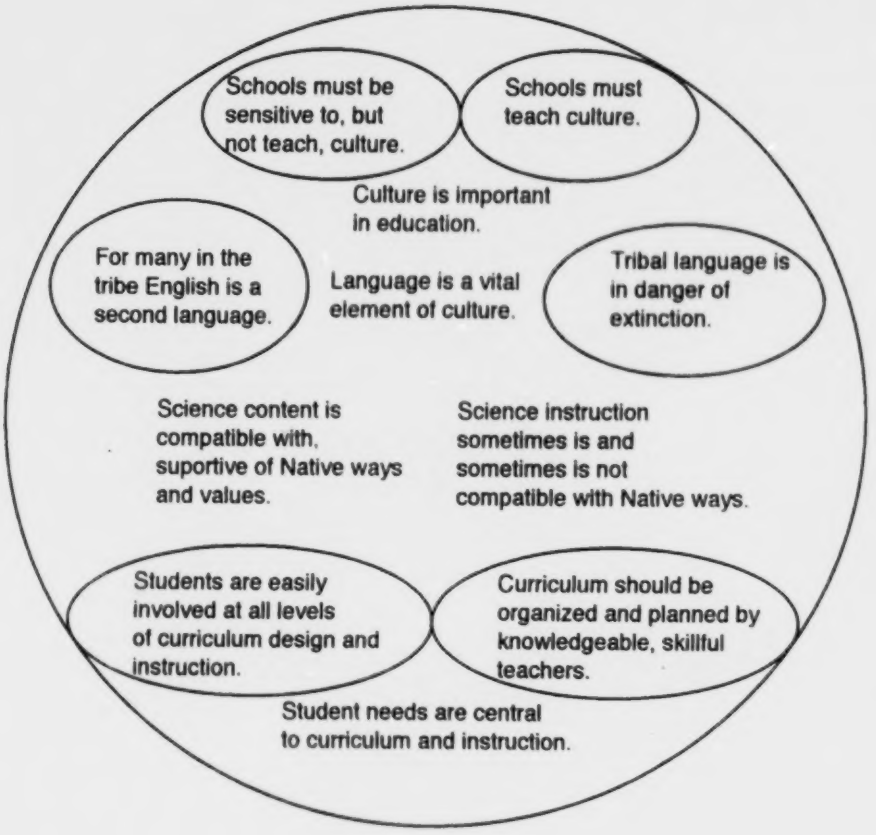
Schools must be sensitive to, but not teach, culture.
Schools must teach culture.
Culture is important in education.
For many in the tribe English is a second language.
Language is a vital element of culture.
Tribal language is in danger of extinction.
Science content is compatible with, suportive of Native ways and values.
Science instruction sometimes is and sometimes is not compatible with Native ways.
Students are easily involved at all levels of curriculum design and instruction.
Curriculum should be organized and planned by knowledgeable, skillful teachers.
Student needs are central to curriculum and instruction.

*Figure 2.* A comparison of participant beliefs.

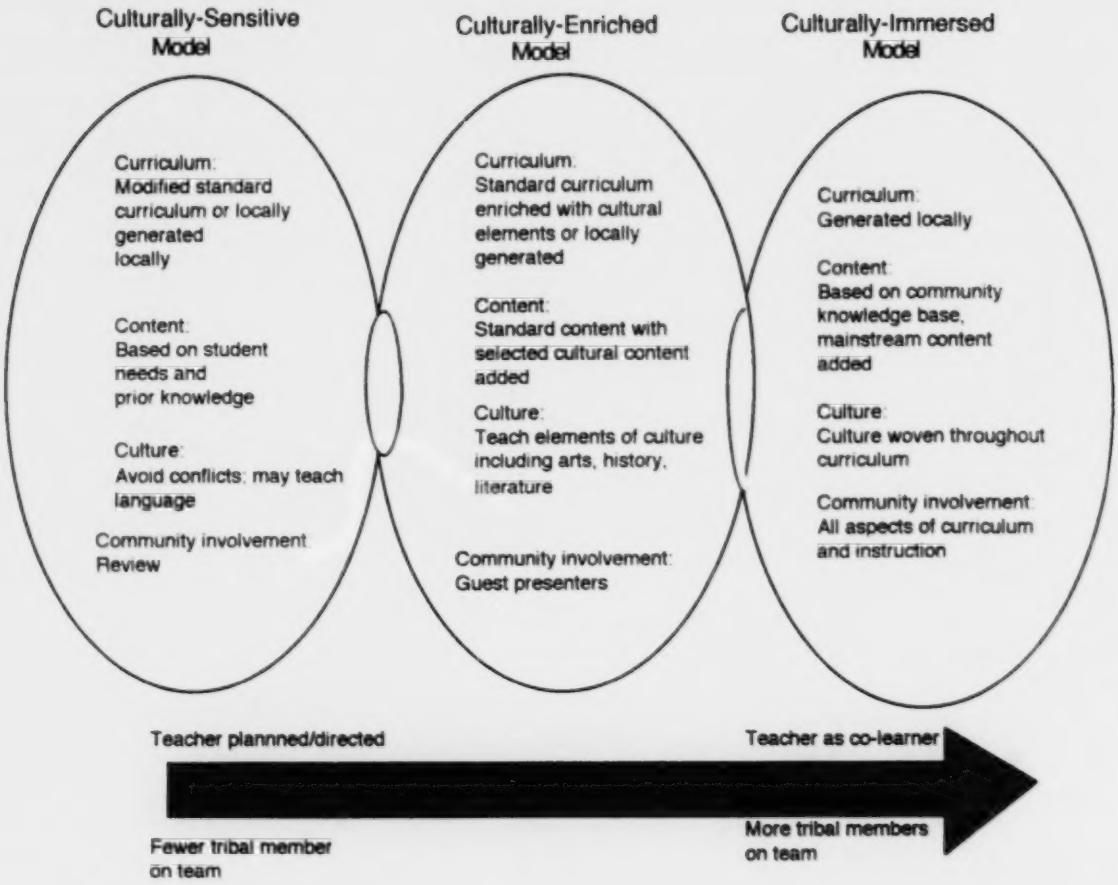


*Figure 3.* Models of curriculum development by teams from Native American Indian Schools

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